



Continuing Progress in 450mm Development



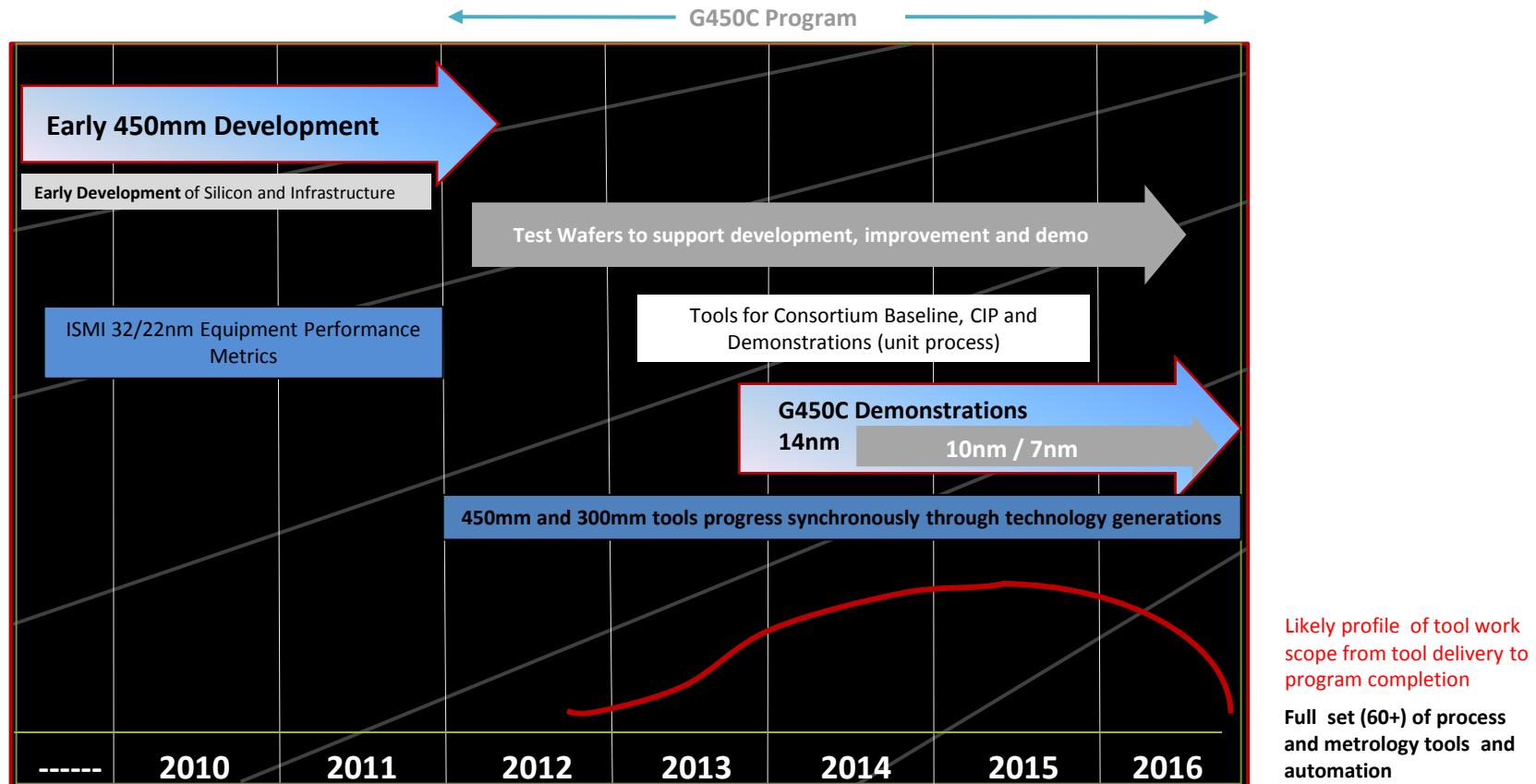
October 8, 2014
SEMICON Europa

Key Messages

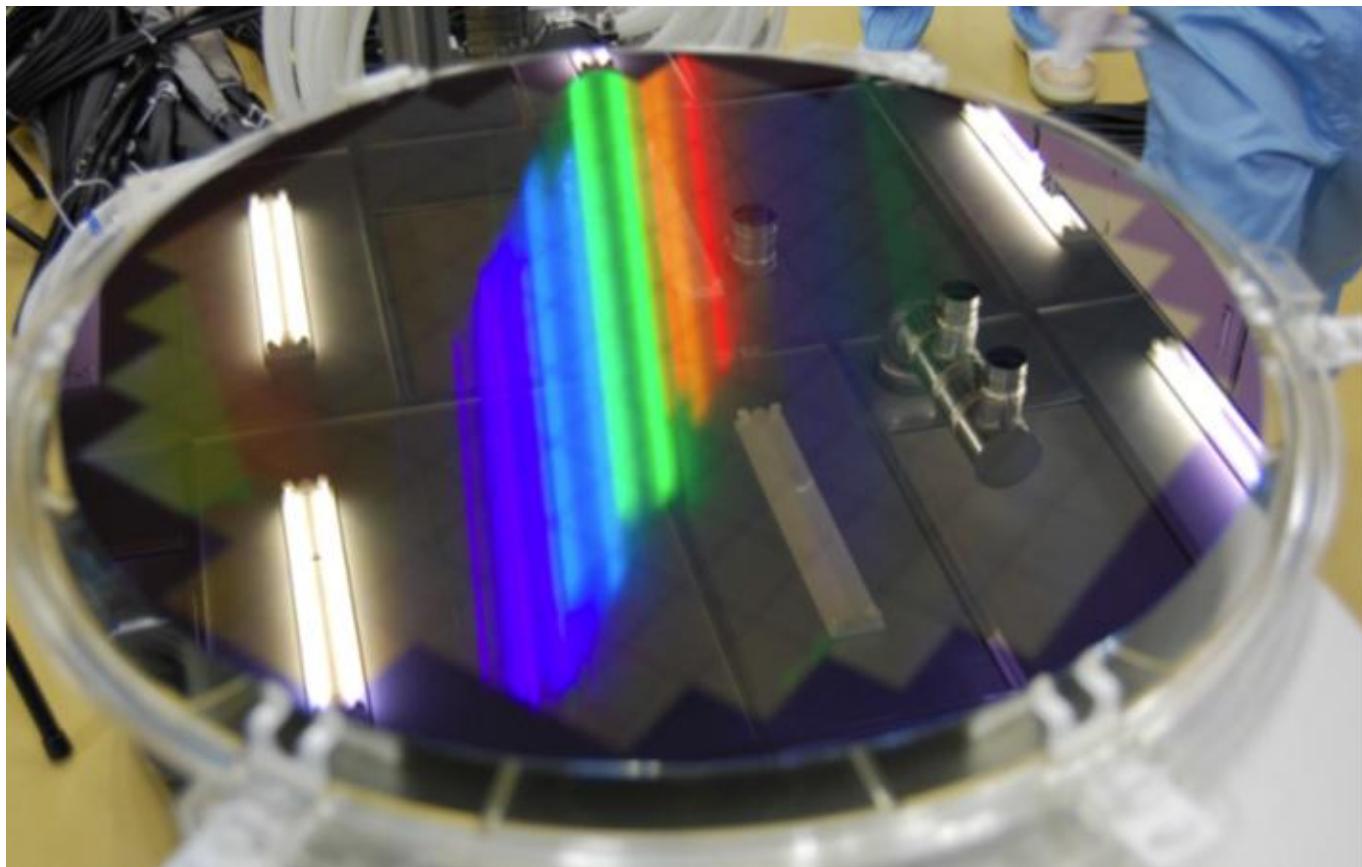
- Program progress continues with broad Supplier support
- Technical results are excellent with few capabilities identified as challenges
- Wafer supply
 - Initial M1 grade wafers received
 - Notchless wafer standard ballot approved

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Development and Technology Intercept Targets



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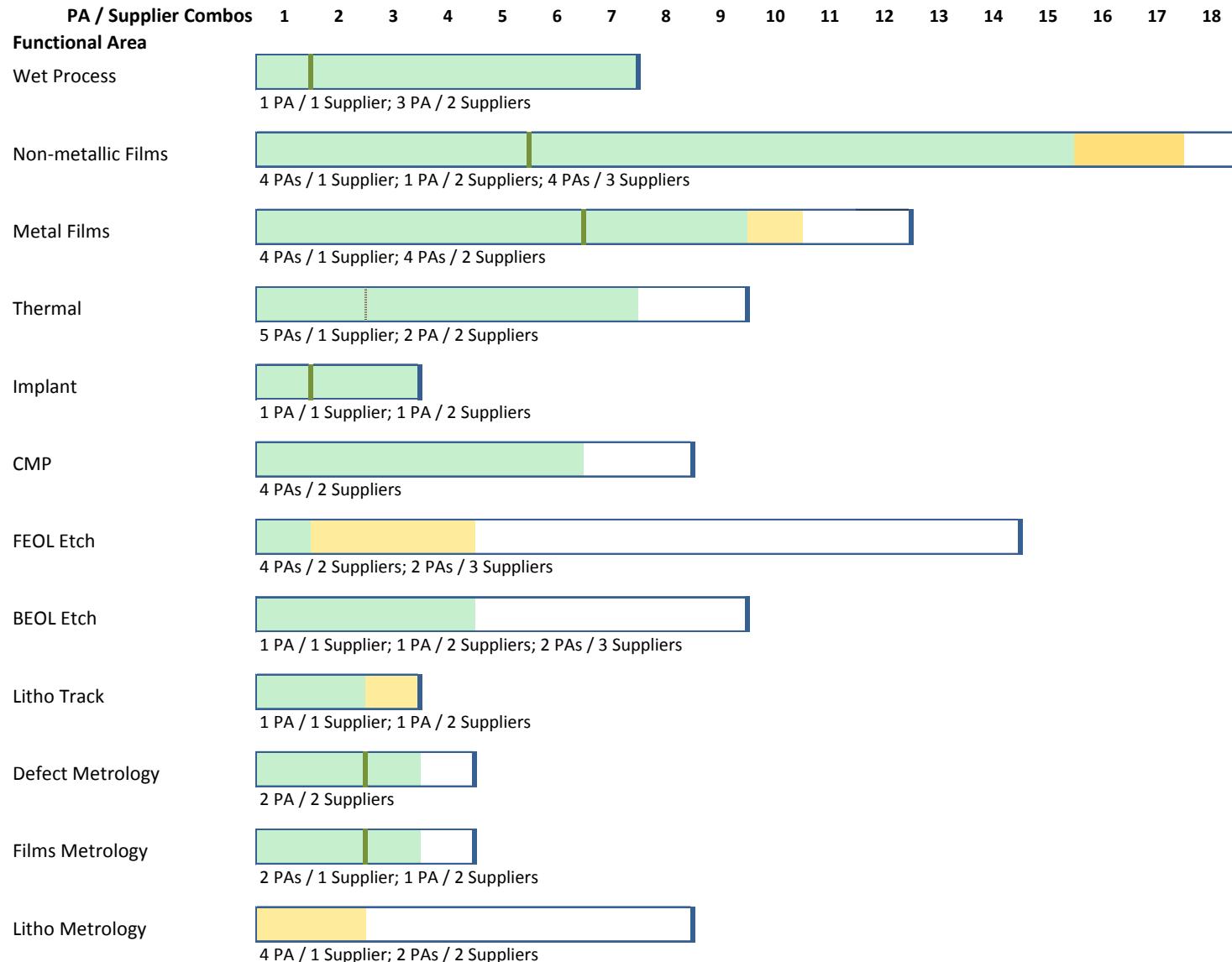
450mm 193i Patterned Wafer
Courtesy Nikon Corporation

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Process Capability Data Progress



█ Total Process Application (PA) / Supplier combinations in Program
█ Tools meeting Program goal █ New 10nm goal not met
█ Tools with data as of September
█ Tools projected to have data by year-end



EPM Refresh

- Sub-10nm EPM published as of SEMICON West
- Based on the uncertainties of sub-10nm process applications, modified metrics to include various process options
 - “Metal-plug” to replace “W-plug”; “barrier” instead of “Ti/TiN barrier”; “salicide” instead of “Ni salicide”.
 - Modified epitaxy to include possible options beyond SiGe.
 - Include ALD option for various films.
- Instead of planar, FIN/STI structure will be the target structure
- Design rules and aspect ratio: referred but not fully aligned to ITRS roadmap. Modification based upon:
 - Inputs from member companies, suppliers and collaborating consortia
 - “Realistic and achievable” for tool qualification and CIP goals.

Thanks to EEMI450 Partners for Valuable Input!

G450C / EEMI450 / Metro450 Collaboration

- EEMI450 feedback (including IMEC and Suppliers) improved multiple parameters in sub-10nm Equipment Performance Metrics
- Joint planning on ASM furnace demo at G450C and Recif sorter demo at IMEC: standard methods / data exchange
 - Working with Metro450 to address slip measurement
 - Planning contamination analysis by Fraunhofer and TNO
- Planning fabrication of standard calibration wafer with Metro450

Ongoing Facilities / EHS work with F450C

- Pump / Abatement Green Mode
 - Communication network installed
 - Baseline fingerprinting under way
- Utilities use rates, effluent characterization
 - Sensors, data collection system installed
- GHG emissions
 - Expect to begin 4Q14
- He recycling
 - Defining project scope

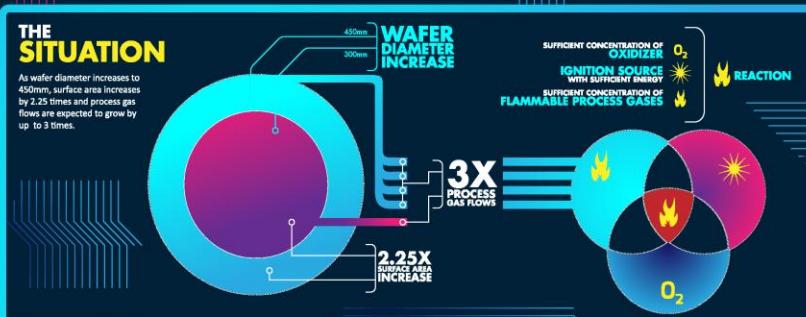
EDWARDS G450C

TRANSITION TO 450mm

Rethinking the approach to higher 450mm process gas flows: a case study

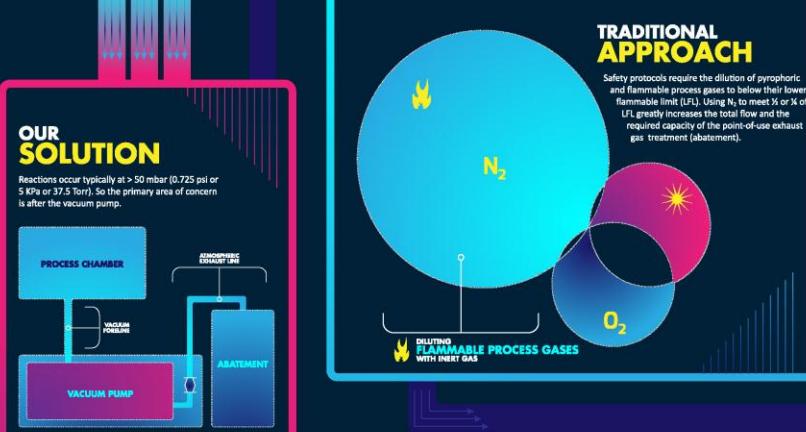
THE SITUATION

As wafer diameter increases to 450mm, surface area increases by 2.25 times and process gas flows are expected to grow by up to 3 times.



OUR SOLUTION

Reactions occur typically at > 50 mbar (0.725 psi or 5 kPa or 37.5 Torr). So the primary area of concern is after the vacuum pump.



Flammable gases are present in the process recipes. Ignition potential is part of the mechanics of the pump and inhibiting oxidizer addition (ambient air) would prevent reaction. So we propose to ensure no air enters the connections and monitor the connections after the pump.

WAFER DIAMETER INCREASE

3X PROCESS GAS FLOWS

2.25X SURFACE AREA INCREASE

SUFFICIENT CONCENTRATION OF OXIDIZER

O₂

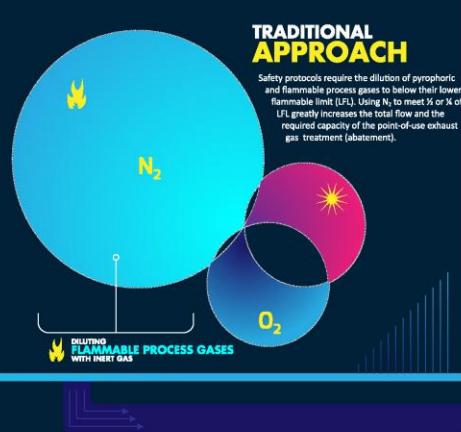
SUFFICIENT CONCENTRATION OF FLAMMABLE PROCESS GASES

IGNITION ENERGY

REACTION

TRADITIONAL APPROACH

Safety protocols require the dilution of pyrophoric and flammable processes to below their lower flammability limit (LFL). Using N₂ to meet X% or X% of LFL greatly increases the total flow and the required capacity of the point-of-use exhaust gas treatment (abatement).



INHIBITING OXIDIZER ADDITION

N₂

O₂

DILUTING FLAMMABLE PROCESS GASES WITH INERT GAS

EXTRA N₂ NEEDS PURCHASING

ADDITIONAL N₂ COSTS \$5K

TOTAL GASES NEEDING ABATEMENT

H₂ FROM PURGE

ADDITIONAL ABATEMENT CAPACITY \$83K

TRADITIONAL RESULTS

The LFL of silane is 1.37% of total flow. At a Silane gas flow of 2 slm, 1% LFL would require the addition of 292 slm of N₂ at the exhaust of the pump. If 96 slm comes from the pump purge another 196 slm must be added. If 600 slm of abatement capacity costs (simplified) \$200,000 and N₂ costs \$0.5/m³ then:

\$88K

TOTAL GASES NEEDING ABATEMENT

INTEGRATING MONITORED CONNECTIONS INTO AN INTEGRATED SUBFAB PACKAGE CAN PROVIDE SAFE COST REDUCTION AND RESOURCE CONSERVATION

THE BENEFITS

INTEGRATED SUBFAB PACKAGE

COST REDUCTION

SAFE

RESOURCE CONSERVATION

TEST

CONFIRM

UP-STREAM PRESSURE

DETECTION PRESSURE

RESULT

1	Protection during leak	79 mbar	7 mbar	YES
	Leak detection limit			
2	System protection which connection	35 psig	7 psig	YES
	Protection of intact connections unaffected by pump transients			

INTEGRATING MONITORED CONNECTIONS INTO AN INTEGRATED SUBFAB PACKAGE CAN PROVIDE SAFE COST REDUCTION AND RESOURCE CONSERVATION

INTEGRATED SUBFAB PACKAGE

COST REDUCTION

SAFE

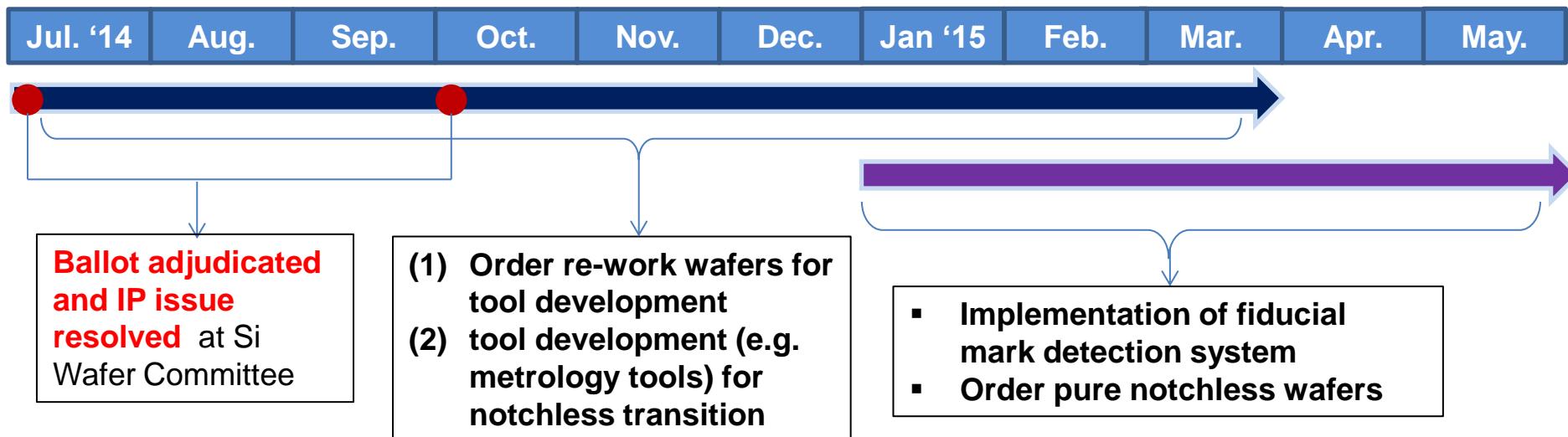
RESOURCE CONSERVATION

ASMC 2014

Addressing process gas use rate concern at 450mm that can benefit 300mm!

Notchless Wafer Timeline

- The notchless standards (M1 & M20) will be completed by October, 2014. The IP issue should be resolved at SEMICON Europa in October
- The notchless transition started already: some tools, e.g. KLA-T SP3 & WS3 and Nikon 193i, can take notchless wafers now
- The primary fiducial mark has been decided at 180° from the notch of re-worked wafers. G450C plans to order up to 3000 re-work wafers
- G450C plans to order up to 700 pure notchless wafers for future usage



450mm Standardization Support



- **SEMI Equipment Energy Savings Mode Task Force (aka “Green Mode”)**
 - Developing fab-wide control framework → likely 2015 SEMI standards
- **SEMI 450mm Physical Interfaces & Carriers**
 - Working with ITG-J to eliminate 450mm carrier issues found at G450C
- **SEMI Defectivity Subcommittee**
 - Working to improve quality of consumables causing sub-10nm defects
 - Starting with ‘O’-rings and valve seals
- **SEMI Wait Time Waste Task Force**
 - SECS log file data extraction for G450C offsite equipment
- **450mm Component Lift Working Group**
 - Component lift guidelines issued

Summary

- 450mm technical results are excellent
- 193i patterning capability demonstrated
- Notchless wafer standard approved
- Program progress continues
- Global collaboration important as ever

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